A CROSS-SECTIONAL STUDY OF RENAL DONORS

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CERTIFICATE

This is to certify that this dissertation entitled "**A CROSS – SECTIONAL STUDY OF RENAL DONORS**" submitted by **Dr Shivakumar.D** to the Faculty of Nephrology, The TamilnaduDr.MGR Medical University, Guindy, Chennai-600032, in partial fulfilment of the requirement for the award of DM Degree, Branch III (Nephrology) is a bonafide work carried out by him under my direct supervision and guidance, for the academic period from August 2011 to February 2014.

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DECLARATION

I Dr. D. Shivakumar declare that I carried out this work on "A CROSS – SECTIONAL STUDY OF RENAL DONORS" at the Department of Nephrology, Kilpauk Medical College. I also declare that this bonafide work or a part of this work was not submitted by me or any other for any award, degree, diploma to any university, board either in India or abroad.

This is submitted to the Tamilnadu Dr.M.G.R. Medical University, Chennai in partial fulfilment of the rules and regulations for the D.M. Degree examination in Nephrology.

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Abbreviations and Acronyms

BSA - Body Surface Area

CKD - Chronic Kidney Disease

ECG - Electro cardiogram

ESRD - End stage renal disease

GFR - Glomerular Filtration Rate

HBV - Hepatitis B virus

HOTA - Human Organ transplantation act

HCV - Hepatitis C virus

HIV - Human immunodeficiency virus

IMA - Isolated Medical Abnormalities

KDIGO - Kidney disease Improving Global Outcomes

RRT - Renal Replacement therapy

Introduction

Chronic kidney disease (CKD) is defined[1] by KDIGO as abnormalities of kidney function or structure, present for more than 3 months, with implications for health:

1. Albuminuria >30mg/ 24 hours

2. Abnormal urinary sediments

3. Dyselectrolytemias and other abnormalities due to tubular disorders

4. Abnormal histology

5. Abnormal imaging

6. History of renal transplantation.

7. Decreased GFR < 60 ml/ min/1.73m^2 (GFR categories G3a – 5)

Based on Glomerular filtration rate (GFR), the 5 categories are

Category	GFR in ml/ min per 1.73 m^2
G1	> 90
G2	60 to 89
G3a	45 to 59

G3b	30 to 44
G4	15 to 29
G5	less than 15 (End stage renal disease / ESRD)

The incidence and prevalence of chronic kidney disease is steadily increasing worldwide. This is largely due to the diabetes epidemic. According to Centre for Disease Control (CDC) data, renal problems like nephritis and nephrosis constitute the ninth common case of death[2]in United States. And essential hypertension and hypertensive renal disease is the thirteenth common cause of mortality[2]. In CKD population the major cause of death is by cardiovascular event. The risk of cardiovascular death increases with each stage of progression of CKD. In India, the projected number of deaths due to CKD in 2008 was around 5.21 million and is expected to be around 7.63 million in 2020[3].

Once the patient reaches ESRD, one or the other form of renal replacement therapy (RRT) becomes mandatory for survival. The available form of RRT includes dialysis and renal transplantation. Dialysis can be either Peritoneal dialysis or Hemodialysis. Overall, kidney transplantation is considered superior to dialysis unless there are contraindications to it and can be said as the best form of RRT that can be offered to a patient with ESRD. Dialysis does not reverse or improve some complications of uremia such as anemia, sexual dysfunction, peripheral and autonomic neuropathy, but a transplanted kidney

does. Thus the quality of life of transplant recipients is markedly better than that of chronic dialysis patients. There is also a significant decrease in cardiovascular mortality in transplant recipients[4].

The source of kidney for transplant can be either from live or cadaver donors. The outcome is expectedly better in recipients of kidneys from live donors. On an average, the living donor kidney functions for 12 to 20 years and that from deceased donor kidney functions for 8 to 12 years. The proportion of contribution from either source varies from place to place in the globe. In western world, majority of the kidneys are retrieved from cadavers. And live donation is steadily increasing there. In countries like Japan live donors form the major source of kidneys for transplant.

In India where 3000 – 4000 renal transplantations take place annually, the donor pool is mainly from live donors who are mostly related to the recipient. The awareness about deceased donation is increasing steadily in India. In a few states viz. Tamilnadu, Gujarat and Maharashtra, deceased donors form a significant percentage of renal transplantation. Still cadaver donors contribute only for 2 percent of the total renal transplantation. In other words, 98 percent of kidneys for transplant is from live donors.

The live donors are related to the recipient in the form of parents/ siblings/ children/ aunt /uncle and in some cases can be just emotionally related. The

evaluation of donor is done meticulously and comprehensively to ensure he/she is healthy and fit for donation. And moreover the donor is not at increased risk of renal disease or other major illnesses in the future.

After donating a kidney, the remaining kidney increases its function to compensate for its lost pair. In a short time after donation, the total GFR of the single kidney reaches 70 - 80% of the two kidney GFR. But do donors show signs of loss of half of their renal tissue with time, such as development of proteinuria, hypertension or accelerated decline in renal function with aging? There have been several studies that have been reassuring and some studies revealing the risks acquired due to donation. This is yet another study in South Indian kidney donor population.

AIMS OF THE STUDY

1. To evaluate kidney donors, after donor nephrectomy, for their current precise state of renal function
2. To look for development of new onset – proteinuria, hypertension, anemia or diabetes in the above group
3. To assess for the frequency of complications that occurred to them in the immediate post- operative period
4. To know about development of any significant medical problems, which might be or might not be related to kidney donation

Review of literature

HISTORY OF RENAL TRANSPLANTATION

The first successful live donor renal transplantation in the world was done by John Murray in December 23, 1954[5]. It was between identical twin brothers at the Peter Bent Brigham Hospital, Massachusetts. The graft functioned for eight years. This was the first breakthrough that continues to change the lives of millions of CKD patients worldwide.

Total body irradiation was used to suppress the immunity of the recipient to tolerate the graft[6]. Azathioprine was the first immunosuppressant drug to be used in 1960[7]. Then came steroids, which was initially used for reversal of rejection and later for prevention. Cyclosporine was first used in 1978 and Tacrolimus in 1987. Induction agents have been in use since early 1980. Sirolimus was introduced in 1999. The last drug to be approved by FDA was Belatacept.

As the science of immune-suppression evolved, successful renal transplantation also evolved to donation from fraternal twins to sibling donation to non sibling donors. Deceased donor renal transplantation was first successfully done in 1962 in Boston.

In India, the first successful transplant was done in Christian Medical College, Vellore in February, 1961 by Dr KV Johny And Dr.Mohan Rao. More than 40 years since then, there are as more than 200 renal transplant centers in India. The transplantation of human organs ac, 1994 (THO/ HOTA) regulates the transplant programs in India. It prohibits live unrelated transplant and legalizes deceased donation after confirmation of brain-death.

As of now, renal transplantation has become the definite therapy for patients with ESRD. The proportion of live and deceased donors in a population is determined by medical, societal and cultural factors.

DECEASED DONORS

Kidneys can be harvested from patients who are brain-dead or after cardiac death. In Spain, almost 95 percent of organs are retrieved from deceased donors. The reason for such a high rate in Spain is its policy that, for all eligible cadavers consent is presumed unless they opt out[8]. In United States of America, deceased donors contribute 50 percent of the donor pool. Due to increased incidence and prevalence of ESRD, the number of patients on waiting list for deceased donor kidneys is very high. And there is annual rise in mortality for patients who are on waiting list. The chance of getting a deceased kidney goes down for highly sensitized patients and for those with high PRA (Panel Reactive Antibody). To improve their chances of survival, living donor transplantation is the alternate option.

LIVE DONORS

With the presently available immunosuppressive medications, use of laparoscopic donor nephrectomy and superior graft function, living donors continue to rise. Persons who are medically and psychologically fit can donate their kidneys irrespective of the biological relationship to the recipient.

Live donors can be related or unrelated to the recipient. These donors know who the recipient is and they are called as directed - donors. The only benefit of this live donation is the level of psychological satisfaction achieved on seeing their donated kidney functioning well in the recipient. Non – directed donors are those who come forward to donate one of their kidneys to some unknown ESRD patients. They are also called as altruistic donors. In United States, non – directed donors contribute about 2.5 of living donor transplantation. These non – directed donors may not feel the psychological satisfaction perceived by directed donors.

The live donors are usually blood group compatible with their recipients. In case there is no blood group compatible donor, there are still two options for live donation. First is the use of paired kidney exchange or simply the donor swapping. Second, transplant can be safely done from an ABO incompatible donor after following specific immunosuppression protocols to remove and reduce the anti-blood group antibodies in the recipient.

The outcomes of patients who are on maintenance dialysis for longer duration before transplant are inferior to those who get an allograft early. This waiting time is usually longer for deceased donor transplant. The survival advantage for recipients is most likely with a live donor. In some situations, when a live donor is readily available, transplant is done even before the commencement of dialysis. This is called Pre-Emptive transplantation and is done in children and in patients with type 1 Diabetes mellitus.

The donor evaluation follows the Amsterdam guidelines[9] adopted by the Transplantation society in 2004. Despite the willingness to donate, there are a few contraindications to live kidney donation, both, absolute and relative. They are:

ABSOLUTE CONTRAINIDICATIONS TO KIDNEY DONATION

1. Presence of renal disease (GFR < 80ml/min, proteinuria > 300 mg/ day)
2. Significant urological or renal abnormalities
3. Active malignancy
4. Presence of transmissible infections like HIV, HBV, HCV
5. Poorly controlled psychiatric illness or substance abuse
6. Co- morbid conditions that puts donor at significant risk for surgery
7. Present pregnancy
8. Cognitive deficit

9. Uncontrolled hypertension or requiring multiple medications
10. Recurrent renal stones or bilateral renal stones
11. Diabetes mellitus
12. History of thrombotic disorders or inherited hypercoagulable conditions

RELATIVE CONTRAINDICATIONS TO KIDNEY DONATION

1. Age < 18 or > 65
2. Mild or borderline hypertension
3. Mild urinary abnormalities in the absence of a fall in GFR
4. Obesity
5. Young donors with risk for future development of diabetes mellitus

DONOR WORK UP

The willing donor undergoes comprehensive evaluation before donation. First and foremost is the consent of the donor for the whole process. It should be made by competent adult, free of coercion and after understanding the risks and benefits of donation, all of which is assessed by psychiatric evaluation[10]. The donor has the right to withdraw from the evaluation at any time during the procedure. The donor should be aware of the alternative treatment options for the intended recipient.

The initial evaluation consists of checking for blood group compatibility and preliminary crossmatching for the presence of antibodies against donor cells.

Subsequent evaluation follows the universal medical goals to ensure the donor,

1. Is healthy enough to undergo the surgical procedure
2. Has normal renal function with minimal risk of future renal disease
3. Is not at risk of transmission of communicable disease or malignancy to the recipient
4. Is not at increased risk of medical conditions that can affect the residual renal function

The steps include:

1. Blood grouping and preliminary crossmatching
2. Urinalysis and urine culture
3. 24 hour urine collection for protein and creatinine
4. Calculation of creatinine clearance or nuclear medicine test for GFR measurement
5. Complete blood count, PT and aPTT
6. Fasting blood sugar and Oral Glucose tolerance test
7. Viral serologies for HIV, HBV, HCV
8. Liver function tests
9. Electrolytes panel
10. ECG
11. CXR

12. Cardiac screening
13. USG abdomen
14. Papanicolau smear for women
15. CT angiogram of renal vessels
16. Urine pregnancy test for women in reproductive age group
17. Mammogram in women > 40 years of age
18. Serum protein electrophoresis for donors > 60 yearrs

METHODS OF GFR ESTIMATION

In case of live donation, estimation of renal function of both the kidneys of the donor is vital. Total GFR less than 80 ml/ min is an absolute contraindication to donation, though this cut-off is lowered in some centers. There are numerous methods for estimation and measurement of GFR. They are:

1. Creatinine clearance

2. eGFR calculated by one of the following formulae:
    a) Cockcroft Gault formula
    b) aMDRD[11] equation (2006)
    c) CKD EPI – creatinine[12] equation (2009)
    d) CKD EPI – cystatin equation (2012)[13]
    e) CKD EPI – creatinine + cystatin (2012)[13]

3. GFR measurement by nuclear isotopes

Creatinine clearance:

It is measured by dividing 24- hour urine creatinine excretion by the plasma creatinine. i.e ,

Creatinine clearance = U x V / P

Where,

U – urinary creatinine concentration

V – urine volume

P – plasma creatinine concentration

The calculated creatinine clearance is finally adjusted for body surface area (BSA) and is given as ml / min / 1.73 m^2

Creatinine is freely filtered by the glomerulus and neither reabsorbed or metabolized by the tubules. But 10 to 40 percent of total urinary creatinine is secreted by the tubules. This can rise to 50 percent with decrease in GFR. Thus creatinine clearance usually overestimates GFR. This is partially offset by the overestimation of plasma creatinine in the denominator by the Modified Jaffes' method.

A small percentage of creatinine is also eliminated by the action of bacterial creatininase in the gut, particularly in patients with advanced renal failure.

Creatinine clearance provides a fair estimation of what the upper limit of GFR can be. This is a cost effective of measuring GFR. The major disadvantage is it requires collection of urine for 24 hours, which is cumbersome. Since the same 24 hour urine collection can be useful for quantifying protein excretion, creatinine clearance is used for measuring GFR in most donor work up protocols.

eGFR by Cockcroft – Gault (CG) equation:

when the age, body weight and serum creatinine are known, GFR is estimated by,

$$eGFR = \frac{(140 - \text{Age in years}) \times \text{lean body weight}}{\text{creatinine in mg/ dl} \times 72}$$

for females, the calculated value is multiplied by 0.85, due to their smaller muscle mass.

eGFR by CG equation is not adjusted for BSA. It is not accurate when GFR is above 60 ml/min. It was originally developed using older creatinine assay methods which have been obsolete now. It usually overestimates GFR by 10 to 40 percent. Still, though valuable in the setting of drug dosing, this is also useful in donor eGFR estimation.

eGFR by aMDRD equation:

The original MDRD (Modification of Diet in Renal Disease) or the Levey formula used six variables, viz. age, sex, race, creatinine , urea, albumin to calculate eGFR which was fairly accurate and standardized to iothalamate clearance.

This was later modified with only four variables, viz. age, sex, race and creatinine and called as abbreviated MDRD (aMDRD). This is as good as the six variable equation.

$GFR = 186 \times Sr_{cr}^{-1.154} \times Age^{-0.203} \times 0.742$ (if female) x 1.210 (if black)

aMDRD is validated in type 1 diabetics, kidney transplant recipients and African Americans, unlike MDRD. Like CG equation, it loses its precision in higher GFR. This equation was accurate when the GFR is less than 60 ml/ min and it loses its accuracy in higher GFR. It is not accepted for eGFR calculation when the GFR is more than 60 ml/ min in North America. In United Kingdom, it is not an accepted formula to report eGFR more than 90 ml/ min.

eGFR by CKD EPI creatinine (2009):

CKD Epidemiological Collaboration study equation is more accurate than aMDRD across a wide range of characters like age, sex, muscle mass and race. It is also better than aMDRD in persons with normal or slightly reduced GFR.

GFR = 141 x minimum $(Sr._{cr}/k,1)^{\alpha}$ x maximum $(Sr._{cr}/ k,1)^{1.209}$ x 0.903 Age x1.018 (if female) x 1.157 (if black)

All the above equations estimate GFR with the help of measured creatinine. They may not be useful for GFR estimation in the following situations:

1. For those on vegetarian diet
2. Those taking creatinine supplements
3. Unusual muscle mass
4. Unusual body weight (obese, amputees)
5. Pregnancy

Cystatin C is 13 kiloDalton protein produced at a fairly constant rate by all nucleated cells. It is freely filtered by the glomerulus and catabolized by the tubules, its urinary excretion being negligible. The generation of cystatin C is not related to muscle mass or dietary intake. But inflammation, thyroid dysfunction and steroid intake can affect the serum levels. Two equations use cystatin C to estimate GFR.

<u>eGFR by CKD –EPI cystatin(2012)</u>:

This equation is not superior to CKD – EPI creatinine equation in terms of accuracy. It is valuable in estimating GFR in population with low creatinine production, like children, elderly and those with cirrhosis of the liver.

eGFR by CKD – EPI creatinine-cystatin (2012):

The equation combining both creatinine and cystatin C is accurate in predicting GFR than when either is used alone.

KDIGO recommends CKD – EPI creatinine 2009 equation be used for estimating eGFR in adults with kidney diseases. And to use cystatin C based equations where eGFR is between 45 to 59 ml/min with no other markers of renal damage.

GFR measurement by nuclear isotopes:

With the difficulties in performing Inulin clearance and non – availability in most places, GFR measurement by nuclear isotopes are becoming the current gold standard of measuring GFR.

The isotopes used include

1. ^{99m}Tc – DTPA (Diethylene Triamine Penta Acetic acid)
2. ^{51}Cr – EDTA (Ethylene Diamine Tetra Acetic acid)
3. ^{125}I – Iothalamate
4. ^{99m}Tc – MAG3 (Mercapto Acetyl Triglycine)
5. ^{99m}Tc EC (Ethylene di Cysteine)
6. ^{99m}Tc – DMSA (Dimercapto succinic acid)
7. Iohexol

Of these, Tc - DTPA and Tc - EC are used for measuring GFR in normal individuals and Tc – MAG3 for those with impaired kidney function.

The clearances are calculated from multiple plasma estimations or by a gamma camera based clearance method. The camera based method is commonly used in many centers.

URINALYSIS:

Normal daily protein excretion is less than 150 mg. Proteinuria greater than 250 mg in 24 hours urine collection needs re-evaluation. Persistence of proteinuria indicates renal disease and precludes donation.

Hematuria is defined as the presence of more than 5 RBCs per HPF. Presence of hematuria needs systematic evaluation to rule out glomerular diseases, familial causes like Thin Basement Membrane Disease, Alports' Syndrome, renal calculi and infections. Cystoscopic examination is done to rule out bladder malignancy in elderly donors.

Pyuria is usually done to urinary tract infections and prostatis. It may also be due to nephrolithiasis, tubulointerstitial diseases or rarely genitourinary tuberculosis.

These are excluded before donation.

HYPERTENSION:

JNC 7 defines hypertension as blood pressure greater than 140/ 90 and is staged as

Stage	Systolic BP in mm of Hg	Diastolic BP in mm of Hg
Pre- hypertension	120 - 130	80 – 89
Stage 1	140 – 159	90 – 99
Stage 2	160 & above	100 & above

Donors with mild hypertension, well controlled with drugs, with normal GFR, normal urinalysis and without target organ damage are eligible to donate. As already mentioned, uncontrolled hypertension or resistant hypertension precludes kidney donation. They should be explained of the little chance of progression of hypertension and the need for frequent follow-up.

DIABETES MELLITUS:

American Diabetes Association defines diabetes mellitus by the presence of one of the following[14]:

1. Fasting plasma glucose (FPG) $\geq$ 126 mg/ dl on two or more occasions

2. 2 hour plasma glucose after 75 gm glucose is $\geq$ 200 mg/ dl on two or more occasions
3. Random sugar $\geq$ 200 mg/ dl in the presence of polyuria, polyphagia and polydipsia
4. Glycated Hemoglobin $\geq$ 6.5 %

Impaired Fasting Glucose (IFG) – FPG between 100 to 125 mg/ dl

Impaired glucose tolerance (IGT) – 2 hour post between 140 to 199 mg/ dl

Frank diabetics cannot donate their kidneys. Persons with IFG and IGT are at increased risk for future diabetes. Presence of other comorbid conditions precludes donation in this group also. Elderly, normotensive, non-obese persons with IFG and IGT can be evaluated further for kidney donation.

OBESITY:

BMI more than 30 is considered as obesity. It is considered to be a risk factor for metabolic syndrome, diabetes mellitus, hypertension, fatty liver, dyslipidemia, proteinuria, nephrolithiasis, and chronic kidney disease. There are many transplant centers across that preclude obese donors with BMI more than 35. All obese donors who are otherwise fit for donation should be encouraged to lose weight prior to donation. Post donation, it should be stressed upon them to continue their weight control methods. The short term renal

function in obese donors post donation is similar to non-obese donors[15]. The surgical complications are also more in this group.

INFECTIONS:

Transmissible infections, like HIV, HBV[16], HCV[17], CMV, EBV, HHV-6, HHV-8, tuberculosis are thoroughly screened in the donor to prevent morbidity and secondary renal diseases in the recipient.

MALIGNANCY:

History of familial cancer syndromes or previous history of cancer is reviewed with the donor, after which age and symptom appropriate screening for cancer is done. Potential donors with melanoma, lung cancer, renal cell carcinoma, hepatoma and hematological malignancies are excluded from donation. Donors treated for low grade cancer, after a sustained disease-free interval can be considered cured and subjected to evaluation for donor nephrectomy[19]. Though the risk of transmission of malignancy is reduced but not zero even in this group.

NEPHROLITHIASIS:

AN ASYMPTOMATIC POTENTIAL DONOR WITH HISTORY OF A SINGLE STONE may be suitable for kidney donation if:

1. No hypercalcuria, hyperuricemia, or metabolic acidosis

2. No cystinuria or hyperoxaluria

3. No urinary tract infection

4. Multiple stones or nephrocalcinosis are not evident on CT

AN ASYMPTOMATIC POTENTIAL DONOR WITH A CURRENT SINGLE STONE may be suitable if,

The donor meets the criteria shown previously for single stone formers and current stone <1.5 cm, or potentially removable during the transplant

STONE FORMERS WHO SHOULD NOT DONATE are those with,

1.Nephrocalcinosis on x-ray or bilateral stone disease

2.Stone types with high recurrence rates and are difficult to prevent

In one Italian study, 10.3% of donors had developed their first renal stone in a span of 8 years post donation[20].

CARDIOVASCULAR RISK ASSESSMENT:

The donors can be classified into three categories for peri-operative mortality based on the presence of risk factors. They are:

Major predictors

1. unstable coronary syndromes

2. decompensated heart failure

3. significant arrhythmias and

4. severe valvular disease are contraindications to live kidney donation

Most intermediate predictors

1. mild angina
2. previous myocardial infarction
3. compensated or prior heart failure and
4. diabetes mellitus are contraindications to donation

Minor predictors

1.older age,

2.abnormal ECG

3. rhythm other than sinus

4. low cardiac functional capacity

5. history of stroke, and

6. uncontrolled hypertension—warrant individual consideration

PULMONARY ASSESSMENT:

Donors need not undergo a routine pulmonary examination unless they are at risk for COPD or restrictive lung disease. Donors who smoke should be advised to stop it 4 weeks prior to surgery. Alcohol abstinence for 4 weeks prior to surgery is advised to reduce the peri-operative complications.

FINAL CROSS MATCH:

After making sure the donor is fit to donate, final cross matching is done on the day of surgery. If the final cross match is negative, transplantation is done.

DONOR NEPHRECTOMY

The kidneys can be removed from the donor by either open surgical approach or by laparoscopic method.

Open surgical method is a time – tested procedure. Retroperitoneal approach is used. It takes about 2 to 3 hours. The intra – operative complications are minimal.

But it usually leaves a long scar and the donor needs to be in hospital for 5 to 7 days. Moreover it takes 6 to 8 weeks to resume work.

Laparoscopic nephrectomy is the procedure of choice wherever there is skill and expertise. The scar is minimal and has better cosmetic appeal. The hospital stay is also shorter, 1 to 2 days. And donors can resume work after 3 to 4 weeks. Due to delay in procedure, 3 to 4 hours, there is prolongation of warm ischemia time. Despite this drawback, long tern graft outcomes are similar between the two methods. Because of significant benefits to the donor, laparoscopic nephrectomy is being increasingly used. In United States, 75 percent of donor nephrectomies are done by laparoscopic method. This has clearly led to the

increase in live donation there. Some centers use hand assisted laparoscopic method for better results. In case of any unexpected bleeding or unseen anatomic abnormality, the procedure can very well converted to open method.

ADAPTATION AFTER DONOR NEPHRECTOMY

After nephrectomy, the remaining kidney undergoes hyperfiltration and hyperperfusion to increase its GFR. In few days to weeks, the GFR reaches nearly 70 to 80 % of the pre – donation GFR. This is by increase in single nephron GFR. This rise is dependent on the renal reserve of the donor and usually decreases with age. The hyperfiltration is also accompanied by increase in renal parenchymal volume (RPV). RPV correlated positively with single kidney GFR and negatively with age[6] .It is not known for sure yet whether this hyperfiltration can turn maladaptive as in other pathological states like diabetes.

The GFR increases for an average of 15 to 17 years and remains stable for another 8 years. After 23 to 25 years it shows age related decline[21]. There is increase in protein excretion due to hyperfiltration[21]. Narkun -Burkess DM et al[22] compared 56 world war II veterans who had undergone unilateral nephrectomy following trauma with other veterans who had not. The follow-up was done 45 years after nephrrectomy and he found that the former group neither had increased mortality nor increased incidence of ESRD.

IMMEDIATE RISKS

The surgical complications occur in 1 to 3 percent of donors and include

1. Infections of surgical site
2. Pneumonia
3. Urinary tract infection
4. Bleeding
5. Allergic reactions to anesthesia

The surgical mortality rate with donor nephrectomy is 1 to 3 per 10,000, compared to 0.4 per 10, 000 in the age – matched general population[23]. This has been observed in a study over 20 year period.

LONG TERM RISKS

Earlier, donors who were otherwise fully healthy, without any medical problems, were only eligible to donate. With relaxation of co- morbid conditions, otherwise called as Isolated Medical Abnormalities, that can be present in the donor, like mild hypertension, impaired fasting glucose, impaired glucose tolerance, obesity and so on, there has to be a close monitoring of renal donors after nephrectomy. There have been several studies in assessing the long term outcomes of renal donors over different follow up periods. In a study by Goldfarb DA et al[24], renal donor outcomes 25 years after donation were analyzed. He concluded that renal function is well preserved 25 years following

donation. There is increase in protein excretion particularly in males. This was seen in those who had borderline proteinuria before donation. There was no significant difference in blood pressure or renal function between males and females or in different age groups. The incidence of microalbuminuria was reported to be 13 %[24]. In a longitudinal study by R Saran et al[25], donor were evaluated twice after donation, with an average of ten years between each. They concluded that there is increased prevalence of microalbumiuria and hypertension but renal function is well reserved. The long term risk of ESRD in renal donors is 0.3% though low, is ten times that of general population of 0.04%[4]. There are a few negative studies that caution against live donation . Kidney function estimated using Cockcroft Gault Formula and aMDRD revealed a 30 % reduction in eGFR[10]. This study however did not use the gold standard method of measuring GFR, so its validity is questioned.

PREGNANCY POST DONATION:

Donors can contemplate pregnancy 6 months post donation, the time by which hypefiltration reaches maximum. There is no increased risk of complications in donors and age-matched cohorts. In an observation by Ramcharan and Matas[26], 33 donors reported 72 pregnancies, of which 25 had not been pregnant before donation. In this group of 33 donors, 2 had hypertension in the first trimester and 1 developed pre-eclampsia in third trimester. There was no increase in

proteinuria, deterioration in renal function or increase in maternal or fetal morbidity or mortality.

LONG TERM MONITORING:

The donors are advised to follow a healthy lifestyle, avoid smoking and tobacco, weight reduction and alcohol abstinence. They are advised to avoid Non- steroidal Anti-inflammatory drugs and other nephrotoxic drugs. In follow up visits, they should be evaluated for hypertension, proteinuria and current renal function. Donors with isolated medical abnormalities should be monitored at more frequent intervals.

Overall, renal donors have an excellent quality of life, normal life span, no increased risk of ESRD and no increased risk of mortality with the age-matched general population[27].

Subjects and Methods

Study Design : Cross sectional

Study Place : Kilpauk Medical College Hospital

Study Population - Inclusion criteria:

1. Kidney donors with minimum of 3 months post donation.

2. And who have consented for the study.

Exclusion criteria:

1. Donors less than 3 months post donation

2. Or those not willing to participate in the study

Sample size : 30

Methodology :

The government hospitals in Tamilnadu have a policy to perform kidney transplant only between first degree relations, viz. parent, sibling, spouse or children. Because of this, most of their donors were readily available for evaluation.

40 transplant recipients are on foll0w-up in our hospital.30 donors met the inclusion criteria. 6 donors were not willing to participate in the study and excluded. One donor had died of uterine cancer 2 years post donation, but the recipient is still on regular follow-up. 3 donors could not be traced.

The evaluation of donors was done in the out-patient setting. Their histories and previous medical records were reviewed. They underwent the following:

1. Complete physical examination including blood pressure measurement.

2. Urine analysis – routine, spot PCR (Protein Creatinine Ratio),

3. Complete blood count/ peripheral smear study

4. fasting blood sugar (FBS)

5. serum creatinine and eGFR by CG formula, aMDRD and CKD EPI creatinie equations.

6. ultrasound of abdomen

7. ^{99m}Tc - DTPA renogram

All the results and observations were compared to their pre donation data and analyzed.

Hypertension was diagnosed using JNC 7, Systolic BP > 140 mm of Hg and or Diastolic BP > 90 mm of Hg.

Complete blood count was done in all donors and peripheral smear study done if the Hb was less than 13.5 gm/ dl in males and less than 12 gm/dl in females.

Microscopic hematuria is defined as the presence of > 5 RBCs /HPF. In case of microscopic hematuria, a sample was repeated after ruling out urinary tract infections, menses and other trivial causes.

Normal spot PCR is < 0.3. spotPCR > 0.3 was considered significant and repeated to confirm abnormal spot PCR.

Normal FBS is less than 100 mg/ dl. FBS more than 100 mg/ dl was repeated and classified as IFG, if it is between 100 to 125 mg dl and frank diabetes if greater than 125 mg/dl.

Serum creatinine was measured by Modified Jaffes' (Alkaline picrate) method. eGFR was calculated using Cockcroft - Gault formula, aMDRD and CKD EPI equations. Since most of the donors' records did not have pre-donation creatinine clearances, it was not used for analysis in the study.

USG of the abdomen focusing on the kidney size was done and compared to the pre-donation dimensions. The dimensions were also correlated with GFR measured by nuclear isotope scan, both pre and post donation.

It is our unit protocol to do ^{99m}Tc - DTPA renal isotope scan pre-donation, irrespective of the eGFR values. We subjected all the donors in the study to

isotope scan post donation. The pre-donation and post-donation ^{99m}Tc - DTPA GFR was analyzed. Increase in remnant kidney GFR post donation; difference in GFR pre and post donation were analyzed.

eGFR calculated by different equations were correlated with the GFR measured by isotope scan, both pre and post donation. This was done to assess the applicability of these equations in this population.

CKD was diagnosed when GFR < 60 ml/ min.

Conflict of interest: Nil

Financial grants: Nil

Statistical Analysis: was done using SPSS version 19.0

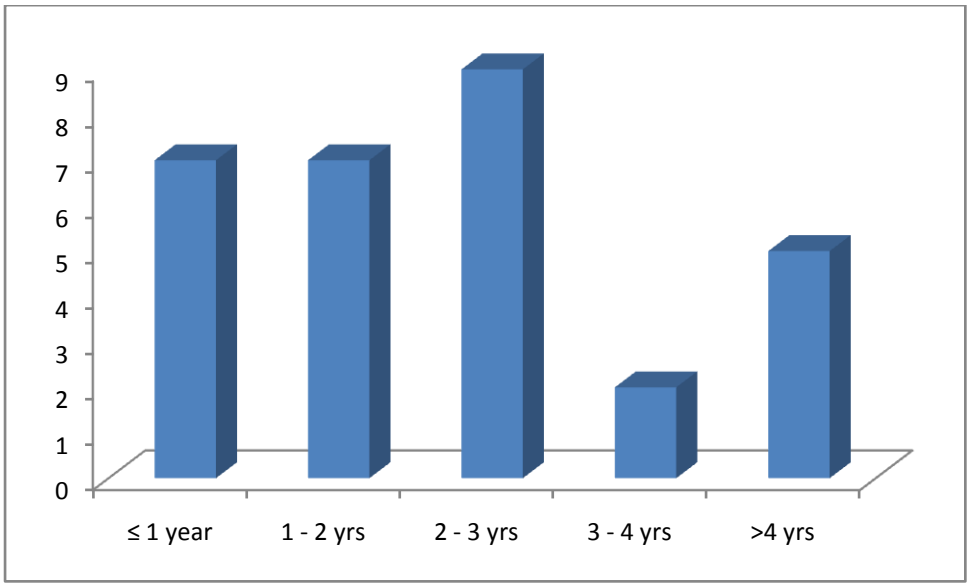
Results of the study

Most of the donors were more than eager to undergo a comprehensive evaluation. They readily consented for participating in the study after a detailed briefing.

The earliest period of post – transplant evaluation was 4 months after transplant.

The longest period was 156 months.

Median period of follow-up was 29 months and is shown below.



Of the 30 donors, 22 (73.3%) were females and 8 (26.7%) were males.

Gender	Number	Percentage
Male	8	26.7
Female	22	73.3

The age distribution of donors was as follows:

Age group (years)	Number	Percentage
18 – 29	1	3.3
30 – 39	7	23.3
40 – 49	14	46.7
> 50	8	26.7
Total	30	100.0

Majority (73.4%) of the donors were in the fourth and fifth decade. 8 donors (26.7%) were above 50 years. The eldest donor was 58 years old at the time of donor nephrectomy and the youngest donor was a lady aged 24, who donated to her husband.

5 donors (16%) had immediate post – operative complications. 2 had fever which subsided on the second day of surgery without any change in ongoing management. 2 donors developed pneumonia which required escalation of antibiotics. There was in delay in hospital stay. 1 donor developed wound dehiscence, requiring secondary suturing. No deaths occurred in the post-surgical period.

Blood pressure readings pre and post donation are as follows:

Systolic BP	Mean	SEM	Mean difference	T value	P value
Pre	119.53	1.56	0.53	0.255	0.801
Post	119.50	2.27			

Diastolic BP	Mean	SEM	Mean difference	T value	P value
Pre	78.13	0.97	-0.67	-0.474	0.639
Post	78.80	1.51			

Where,

SEM refers to standard error of the mean. It denotes the number of samples if taken from the total will deviate from the mean.

T value is the statistical value obtained by Paired t test.

P value is to find out statistical significance, $p < 0.05$ is significant.

The mean systolic BP pre-donation was 119.53 mm of Hg and post-donation was 119.50 mm of Hg and was not statistically different. The mean diastolic BP pre-donation was 78.13 mm of Hg and post-donation was 78.80 mm of Hg and was not statistically significant. Two of the 30 donors (6.7%) developed hypertension, as defined by JNC 7.

Hemoglobin levels were as follows:

Hb	Mean	SEM	Mean difference	T value	P value
Pre	11.40	0.18	0.27	1.035	0.309
Post	11.13	0.29			

The mean Hb pre-donation was 11.40% and it was 11.13% post-donation. The Hb values were not significant.

spotPCR pre and post donation:

Spcr	Mean	SEM	Mean difference	T value	P value
Pre	0.12	0.01	-0.05	-1.593	0.122
Post	0.17	0.03			

There was a marginal rise in proteinuria from 0.12 to 0.17 post-donation, but it was not statistically significant.

None of the donors developed microscopic hematuria post-donation.

FBS pre and post donation are as follows:

FBS	Mean	SEM	Mean difference	T value	P value
Pre	84.50	1.90	-7.40	-3.662	0.001
Post	91.90	2.01			

There was statistical difference with respect to FBS, pre and post donation. 5 of the donors developed IFG, but none of them developed frank diabetes.

Serum creatinine, pre and post donation:

Creatinine	Mean	SEM	Mean difference	T value	P value
Pre	0.84	0.02	-0.17	-6.638	0.001
Post	1.01	0.03			

The mean serum creatinine was 0.84 pre-donation and was 1.01 post-donation and was statistically significant.

Ultrasound of kidney, pre and post donation:

Kidney dimensions, length and width, was measured in millimeters using ultrasound and kidney size or are was calculated and compared in pre and post donation. The depth could not be measured and hence, renal parenchymal volume could not be calculated. Ultrasound measurements were:

Kidney length	Mean	SEM	Mean difference	T value	P value
Pre	98.77	1.26	-9.73	-6.282	0.001
Post	108.50	1.67			

Kidney width	Mean	SEM	Mean difference	T value	P value
Pre	41.17	0.99	-5.37	-5.388	0.001
Post	46.53	1.23			

Kidney size	Mean	SEM	Mean difference	T value	P value
Pre	4082.80	135.29	-999.20	-6.041	0.001
Post	5082.00	195.08			

The mean increase in length was 9.73mm and was statistically significant. The mean increase in breadth was 5.37 mm and was also significant. There was a mean 999.20 mm^2 increase in surface area post donation and was statistically significant.

<u>eGFR pre and post donation</u>:

eGFR was calculated by CG formula, aMDRD and CKD EPI creatinine equation, pre and post donation.

eGFR by CG formula:

eGFR by CG formula	Mean	SEM	Mean difference	T value	P value
Pre	97.93	2.47	15.46	6.494	0.001
Post	72.47	2.67			

The mean eGFR calculated by CG formula was 97.93 ml/ min pre-donation and post donation it was 72.47 ml/ min, with a mean reduction by 15.46 ml/ min.

eGFR by aMDRD equation:

eGFR by aMDRD	Mean	SEM	Mean difference	T value	P value
Pre	84.34	3.46	17.37	5.807	0.001
Post	66.97	2.59			

The mean eGFR calculated by aMDRD was 83.46 ml/ min pre-donation and post donation was 66.97 ml/ min with a mean reduction of 17.37 ml/ min.

eGFR by CKD EPI creatinine :

eGFR by CKD EPI	Mean	SEM	Mean difference	T value	P value
Pre	93.17	3.17	18.00	6.999	0.001
Post	75.17	2.93			

The mean eGFR calculated by CKD EPI cretinine equation was 93.17 ml/ min and 75.17 ml/ min, pre and post with a mean reduction of 18 ml/ min. There was correlation between the three equations with respect to reduction in GFR.

GFR measured by ^{99m}Tc DTPA pre and post:

Total GFR by DTPA	Mean	SEM	Mean difference	T value	P value
Pre	102.53	1.70	21.76	11.715	0.001
Post	80.77	1.14			

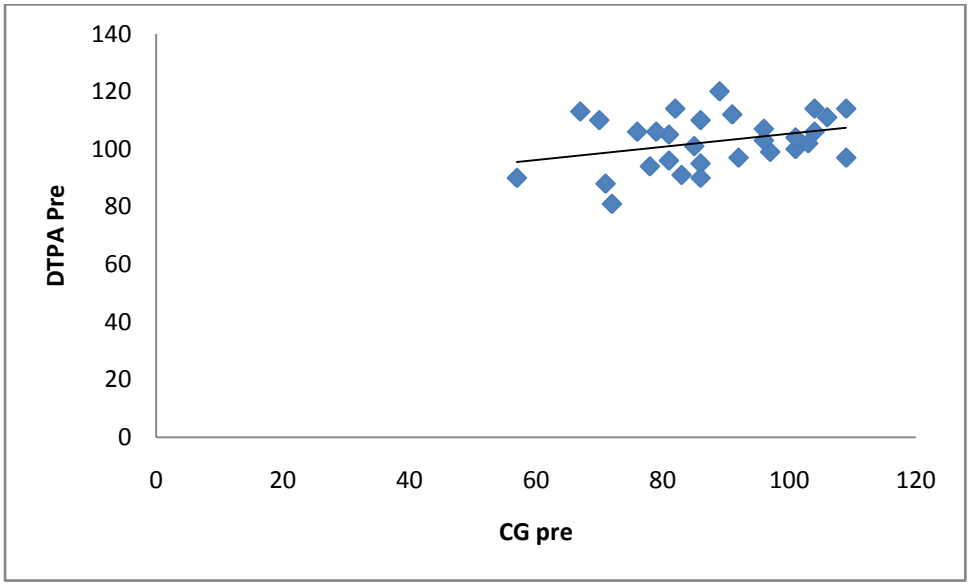
The mean GFR measured by ^{99m}Tc DTPA pre and post donation were 102.53ml/ min and 80.77 ml/ min respectively, with a mean reduction in total GFR by 21.76 ml/ min.

Correlation of eGFR vs GFR measured by ^{99m}Tc DTPA

Pearsons correlation was used to analyze the correlation between eGFR calculated by different equations and that measured by ^{99m}Tc DTPA, in pre and

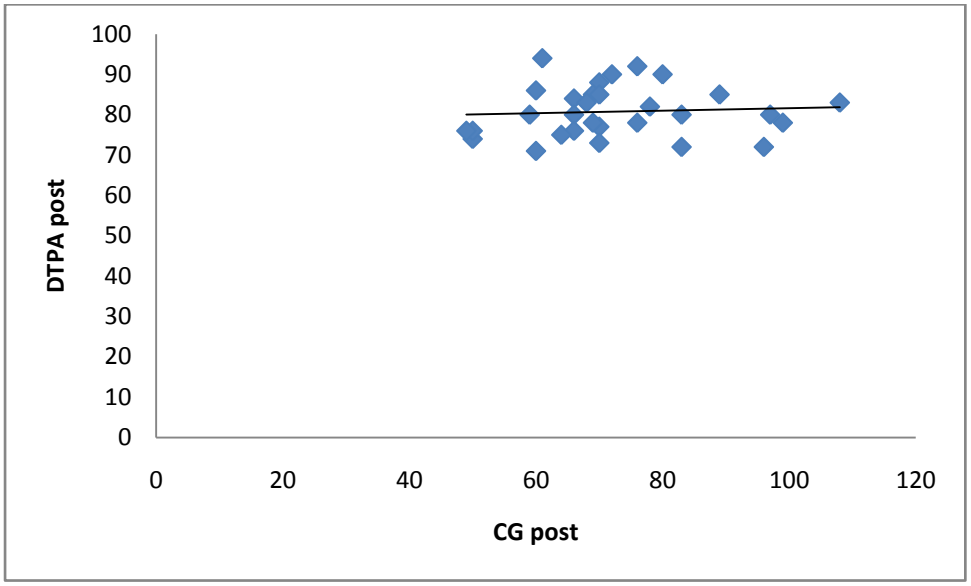
post donation. They are shown by the images below, along with the correlation coefficient r and its p value.

eGFR by CG vs total GFR by ^{99m}Tc - DTPA (pre-donation):



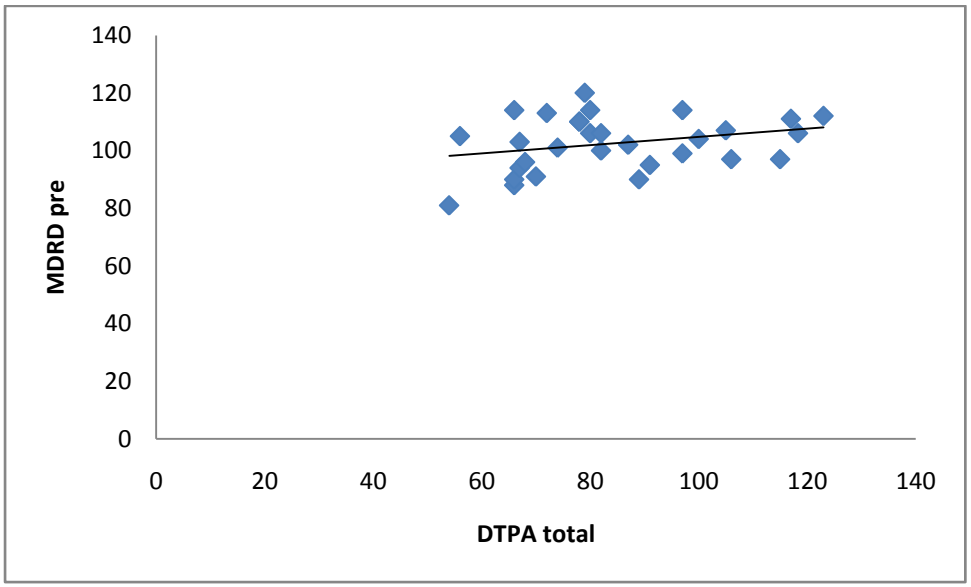
Correlation coefficient r = 0.331, p = 0.074

eGFR by CG vs ^{99m}Tc - DTPA GFR (post donation):



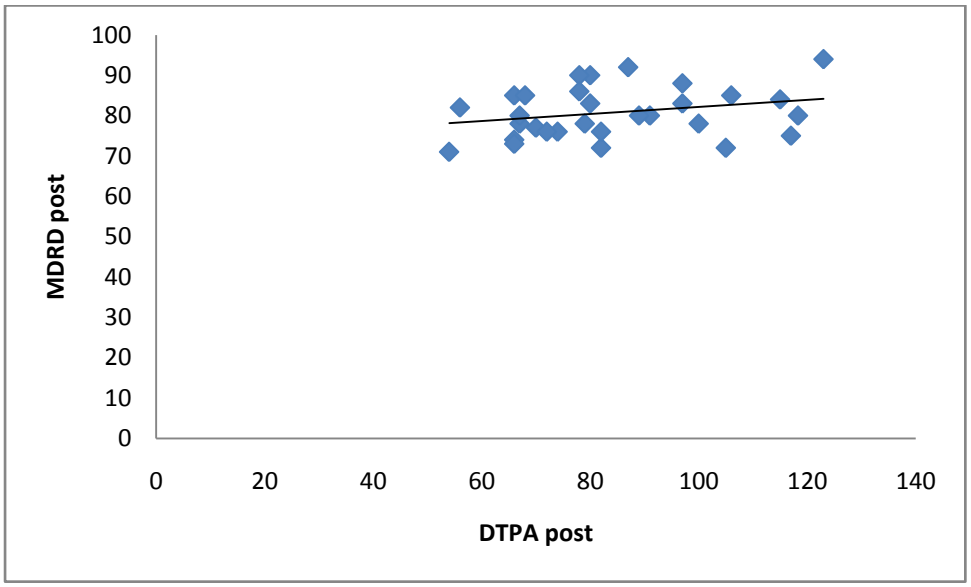
r = 0.071, p = 0.709

eGFR by aMDRD vs ^{99m}Tc DTPA GFR (pre-donation):



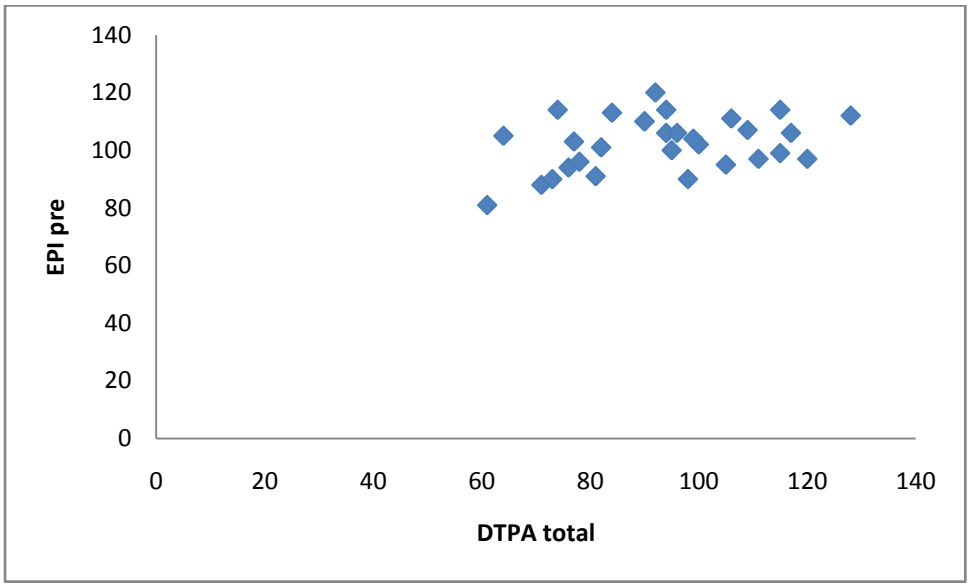
r = 0.291, p = 0.119

eGFR by aMDRD vs ^{99m}Tc DTPA GFR (post donation):



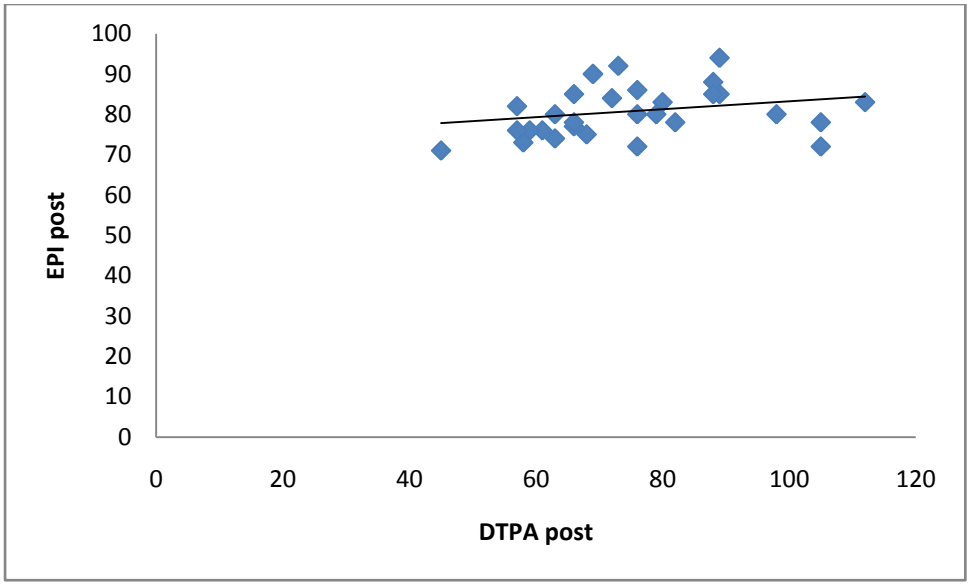
r = 0.164, p = 0.385

eGFR by CKD EPI vs ^{99m}Tc - DTPA GFR(pre-donation):



R = 0.340, p = 0.066

eGFR by CKD EPI vs ^{99m}Tc – DTPA GFR (post donation):



r = 0.254, p = 0.175

Using Pearsons correlation coefficient, it was found that none of the equations for estimating GFR had significant correlation with GFR measured by ^{99m}Tc DTPA. This lack of correlation between eGFR and DTPA GFR led to misclassification of donors as CKD, even before transplantation!

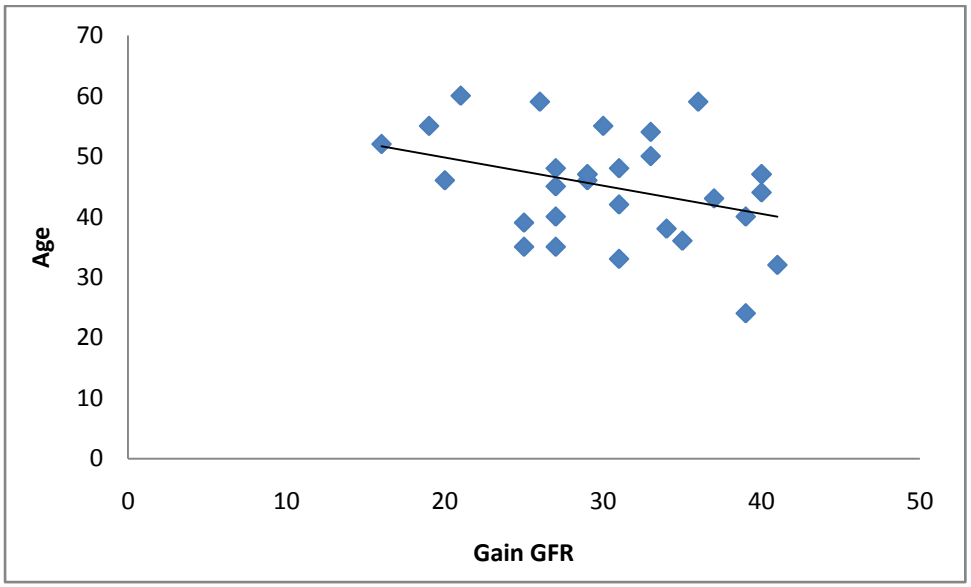
GFR < 60 ml/ min	Pre-donation	Post-donation
CG FORMULA	1	4
aMDRD	2	10
CKD EPI creatinine	0	5
^{99m}Tc DTPA	0	0

Increase in measured GFR by ^{99m}Tc DTPA in remnant kidney:

DTPA total gain	Mean	SEM	Mean difference	T value	P value
Pre	50.87	1.11	-29.90	-22.182	0.001
Post	80.77	1.14			

The mean GFR measured by ^{99m}Tc DTPA of the remnant kidney, pre-donation was 50.87 ml/ min and post donation was 80.77 ml/ min. Hyperfiltration by the remnant kidney resulted in rise in GFR and it ranged from 16 ml/ min to 41 ml/ min and the mean rise in GFR was 29.90 ml/ min.

Age of the donor vs increase in DTPA GFR(post-donation):



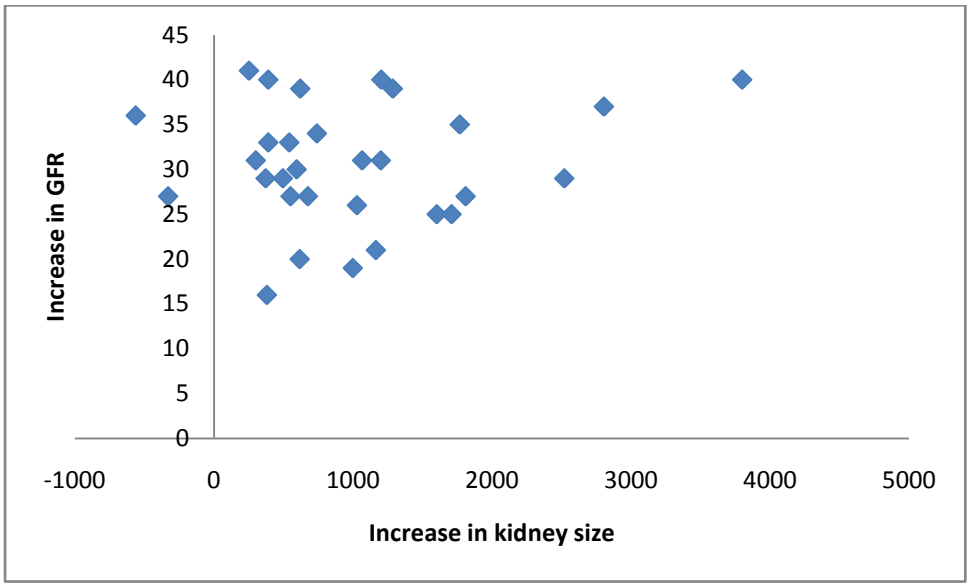
r = -0.362, p = 0.05

There increase in GFR is more when the age of donor is less. In other words, older donors had less compensatory hyperfiltration. This is the expected outcome and it was statistically significant.

Increase in kidney size vs increase in DTPA GFR(post-donation):

Kidney size had no correlation with DTPA GFR , both pre and post donation. Neither did the increase in kidney size and increase in GFR post donation.

The graph depicting it lack of correlation is shown next.


45
40
35
30
25
20
15
10
5
0
Increase in GFR
-1000
0
1000
2000
3000
4000
5000
Increase in kidney size

R = 0.142, p = 0.455

Discussion

Living donors form more than 95 percent of renal transplantations in India. They transform the lives of numerous ESRD patients by their generosity and selfless attitude. Most of them are related to their recipients. Being aware of the morbidity and mortality of CKD patients, most of the donors take good care of themselves to avoid the risk factors for development of CKD and ESRD.

In our study of 30 donors, 22 were females (73.3%) and 8 were males (26.7%). There were 16 male recipients (53%) and 14 female recipients (47%). More females were donors and more recipients were males. This is similar to the observation in studies by Biller et al[28] from Germany and Zimmermann et al[29] from Canada. It has been hypothesized that females think it is their duty to relieve the suffering of their spouse or children. Other factors include increased prevalence of hypertension in males, their higher earning capability and in spousal transplants, wives may be sensitized to their husbands during pregnancy. These make males less likely donors.

In our study, of the 22 female donors, 13 donated to their children, 6 to their husbands and 3 to their brothers. Of the 8 male donors, 4 donated to their children, 2 to their wives and 2 to their siblings.

In our center, open nephrectomy is done and the mean period of hospital stay is 6 to 7 days. Of the 30 donors, 2 developed fever which subsided on the second

day, due to basal atelectasis(6%).2 donors developed pneumonia (6%)with need for escalation of antibiotics and its duration. Their hospital stay was not prolonged. One donor developed wound dehiscence (3%) which required secondary suturing and prolongation of hospital stay. Peri – operative complications are relatively common[30] and include atelectasis (13.5% , prolonged ileus (5.2%), pneumonia (4.5%), urinary tract infection (4.3%). The surgical mortality in donor nephrectomy is reported to be 0.03%[23].

Though there was increase in spot protein creatinine ratio, from 0.13 to 0.17, it was not statistically significant. Though the incidence of late proteinuria in literature has been reported around 3%[30], this has not been linked to the progression of renal disease.
None of the donors in our study had developed microscopic hematuria needing further evaluation.

Though there was no statistical significance in Hemoglobin levels before and after renal donation. Six female donors had developed anemia post donation. They underwent peripheral smear study, pelvic examination and occult blood in stool. Their peripheral smear study revealed microcytic hypochromic anemia. They improved with oral iron.

The concerning issue was the development of impaired fasting glucose in 5 donors (16.5%). One was a male donor and the rest were females. 4 of them

were overweight. The earliest period to development of IFG was 1 year post donation and latest was 6 years. No donor developed frank diabetes. These donors were advised lifestyle modifications, including weight reduction and to undergo frequent monitoring. In a long term study of living kidney donors, 19 of 380(0.5%) developed diabetes over 6 to 34 years[31].The incidence of diabetes has been similar to the general population.

Two (6.6%) donors developed hypertension post donation. One was in JNC Stage 1and one was in JNC Stage 2. Both were obese, female donors more than 50 years of age and 2 years post donation. The donor in JNC stage 1 was advised salt restriction, regular aerobic exercise, weight reduction and frequent monitoring. The other JNC Stage 2 hypertensive donor was started on single anti-hypertensive drug and given the same advice. The incidence of hypertension in donors has been reported to be the same as in general population. Some studies report increased risk of hypertension in renal donors with increasing age and duration after donation[27].

The compensatory hyperfiltration by the remnant kidney leads to a maximum of 70% of pre-donation GFR in about 6 months. There was a mean 29.90 ml/ min increase in the remnant kidney due to compensatory hyperfitration. The range of this increase was from 16 ml/ min to 41 ml/ min. The higher range of rise in

GFR was seen with younger donors. This is similar to the observation reported in literature[32].

The other side of it, kidney donation leads to loss of GFR by 30%. In our study, there was 0.17 increase in serum creatinine post donation which was statistically significant. The rise in creatinine resulted in statistically significant fall in estimated GFR calculated by the three equations, CG, aMDRD and CKD EPI creatinine, though all the three equations did not correlate with ^{99m}Tc - DTPA GFR in this donor population. There was also statistically significant decline in ^{99m}Tc - DTPA GFR, by an average of 21.76 ml/ min. This loss of GFR is similar to that reported in literature[33, 34].

The eGFR calculated by CG formula or the aMDRD and CKD EPI creatinine equations falsely classified many donors as CKD, one donor even prior to donation! This finding is an eye-opener to validate the eGFR equations in our population.

In our donors, there remnant kidney increased its length, width and surface area, all of which were statistically significant. This compensatory increase in size did not correlate with the increase in remnant kidney ^{99m}Tc -DTPA GFR. This is in contrast to the observation by Yasuhito Funahashi et al[31].

Conclusions:

1. The GFR of remnant kidney of living kidney donors in our study is well within the normal range.
2. The compensatory increase in remnant kidney GFR was more in younger donors.
3. Impaired fasting glucose was seen in 16.5% of our donors and was of concern.
4. Hypertension was seen in 6.5% of our donors, which is similar to that seen in general population.
5. There was non-significant increase in proteinuria.
6. Post-operative complications were seen in 16.5% of our donors.
7. There was significant increase in remnant kidney size.
8. Estimation of GFR using CG formula, aMDRD and CKD EPI creatinine equations were not accurate in our donor population, when compared to ^{99m}Tc – DTPA GFR . Hence for accurate determination of GFR before donation in our donors, GFR measured by nuclear isotope methods should be used.
9. With respect to the mean reduction in total GFR post donation, there was correlation between eGFR calculated by using CG formula, aMDRD and CKD EPI creatinine equations

Limitations of the study

1. The number of donors in our study was small, only 30.
2. The study was cross-sectional and the median period of follow-up was only 29 months.
3. Creatinine clearance was not done in our donors and hence its significance and correlation with ^{99m}TcDTPA GFR could not be assessed.

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INSTITUTIONAL ETHICAL COMMITTEE
GOVT.KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Ref.No.3393/ME-1/Ethics/2013 Dt:27.09.2013
CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "A Study on a cross sectional study of renal donors" – For Research Work Submitted by Dr. D.Shivakumar, DM (Neph), PG Student, KMC, Chennai-10.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

25/11/13.

CHAIRMAN,
Ethical Committee
Govt.Kilpauk Medical College,
Chennai

GOVT. KILPAUK MEDICAL COLLEGE
25 NOV 2013
Kilpauk, Chennai-10.

25/11/13

A CROSS SECTIONAL STUDY OF RENAL DONORS – PROFORMA

Name : Age / Sex :

Date of Donor Nephrectomy : Side : Rt / Lt Time since Tx :

Peri–operative complications ;

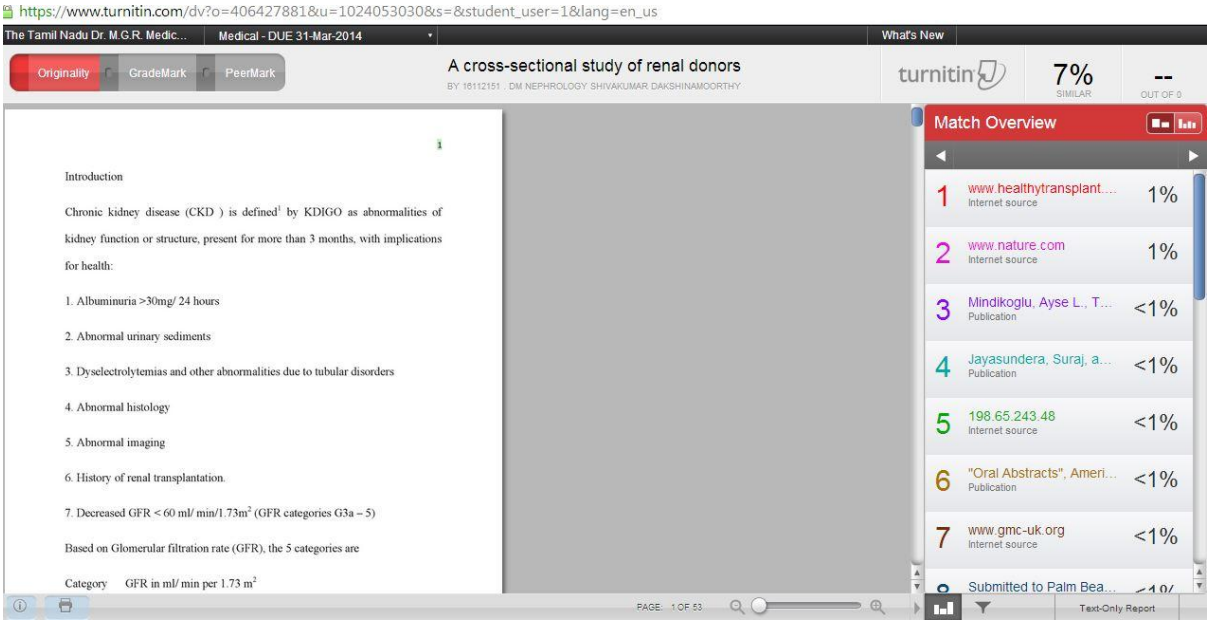
Complaints (if any) :

Examination :

	Pre-transplant	Post-transplant
BP		
Weight/ BMI		
Hb		
Urine Routine		
Urine spot PCR		
Fasting Blood sugar		
Serum.Creatinine		
eGFR by CG formula		
eGFR by aMDRD equation		
eGFR by CKD-EPI creatinine		
USG KUB		
ECG		
^{99m}Tc – DTPA GFR		

S No.	age	sex M-1,F-2	Time trans months	side Rt-1,Lt-2	peri compY 1N2	other	BP sys pre	BP Dia pre	BP Post sys	BP Post Dia	Hb Pre	Hb Post	Urine RBC Pre	Urine RBC Post	Spcr pre	spcr post	FBS Pre	FBS Post
1	33	1	8	1	2	2	110	70	110	70	11	12	2	2	0.2	0.2	68	95
2	55	1	12	1	2	2	110	80	100	80	13	12.5	0	0	0.1	0.4	95	110
3	40	2	30	2	2	2	120	80	130	90	11	9	2	0	0.1	0.19	84	96
4	47	2	50	2	2	2	120	76	120	80	12	11.5	2	0	0.2	0.2	86	93
5	46	1	15	2	2	2	130	80	130	80	14	14	0	2	0.1	0.15	82	87
6	46	2	72	1	2	2	120	80	130	90	11	10	2	2	0.3	1	94	121
7	39	2	35	2	1	fever	110	80	110	80	12	11	0	0	0.1	0.13	90	93
8	45	2	6	1	1	fever	130	80	140	80	10	11.2	2	2	0.1	0.16	90	95
9	48	2	40	2	2	2	120	80	130	80	11	12.1	0	2	0.1	0.09	72	86
10	59	1	16	2	1	wound dehiscence	120	70	120	80	12	10	0	2	0.1	0.05	82	82
11	47	1	55	1	2	2	120	80	130	90	12	13	0	2	0.1	0.1	64	83
12	35	2	22	2	2	2	120	80	120	70	10	8	0	0	0.2	0.2	87	90
13	54	1	30	2	2	2	110	70	130	90	12	14.1	0	0	0.3	0.2	94	86
14	40	2	12	2	2	2	110	80	120	80	11	11.5	0	2	0.2	0.03	53	79
15	47	2	30	2	2	2	130	90	140	80	12	11	0	0	0.2	0.1	98	112
16	24	2	6	2	2	2	130	80	100	70	12	10	2	2	0.2	0.1	80	84
17	43	2	4	2	2	2	110	70	110	70	10	10	0	3	0.1	0.12	79	93
18	35	2	33	1	2	2	116	78	120	80	9.8	9.5	0	3	0.1	0.05	90	94
19	32	2	6	2	1	LRI	110	70	120	70	11	12	0	2	0.2	0.05	89	75
20	48	2	18	2	1	LRI	140	90	140	100	10	9.8	0	3	0.1	0.1	86	113
21	36	2	36	1	2	2	120	80	110	80	13	11	0	0	0.1	0.07	90	79
22	60	2	36	2	2	2	130	80	100	70	11	12	0	2	0.1	0.14	84	90
23	38	2	36	2	2	2	110	70	100	60	11	7.7	0	3	0.1	0.17	92	107
24	42	2	48	1	2	2	110	70	110	80	12	11.8	2	3	0.1	0.1	83	88
25	52	2	16	2	2	2	120	80	100	70	10	12	2	2	0.1	0.13	97	92
26	44	1	156	2	2	2	130	80	130	84	13	12.1	2	2	0.1	0.13	75	82
27	59	1	28	2	2	2	130	80	120	80	11	13	0	0	0.1	0.12	94	96
28	47	2	50	1	2	2	110	80	110	80	13	12.8	2	3	0.1	0.15	78	84
29	55	2	24	1	2	2	120	80	120	80	12	9.8	2	3	0.1	0.15	82	84
30	50	2	24	2	2	2	120	80	120	70	11	9.6	2	3	0.2	0.2	97	88

S No.	USG kid size pre	USG kid size post	creat pre	creat post	eGFR by CG pre	CG post	eGFR by MDRD pre	MDRD post	eGFR by CKD EPI pre	CKD EPI post	DTPA Rt Pre	DTPA Lt Pre	DTPA Total	DTPA Post	lower limit	T Gain GFR	Fall GFR
1	91*39	95*40	0.8	1	104	83	118.3	86	117	98	57	49	106	80	84	31	26
2	110*50	110*55	0.7	1.2	106	64	117	63	106	68	55	56	111	75	75	19	36
3	100*38	116*48	0.8	0.9	79	68	80	69	94	80	54	51	106	83	82	39	20
4	100*40	121*43	0.8	0.9	70	60	78	67	90	76	55	55	110	86	80	29	24
5	117*52	120*46	0.8	0.82	96	96	105	101	109	105	46	51	107	72	75	29	30
6	97*40	120*64	0.8	0.67	89	99	79	95	92	105	62	58	120	78	78	20	36
7	95*45	106*45	1.1	1.2	81	78	56	56	64	57	58	47	105	82	82	25	21
8	100*35	103*40	1.1	1.4	72	60	54	41	61	45	37	44	81	71	80	27	10
9	93*33	99*37	0.7	0.87	86	66	91	69	105	79	49	46	95	80	78	31	12
10	104*50	110*50	1.14	1.2	71	69	66	62	71	66	49	39	88	85	75	36	2
11	100*43	103*47	0.8	1	92	70	106	80	111	89	52	45	97	85	80	40	7
12	90*32	120*45	0.9	1.2	67	50	72	51	84	59	59	54	113	76	84	27	36
13	100*43	110*50	0.9	1.28	86	59	89	59	98	63	42	48	90	80	75	33	8
14	90*40	95*42	0.9	1.06	83	70	70	57	81	66	50	41	91	77	82	27	12
15	102*38	112*45	0.9	0.8	81	89	68	77	78	88	51	45	96	85	80	40	8.5
16	90*41	110*50	0.6	0.9	91	61	123	77	128	89	55	57	112	94	88	39	28
17	93*38	103*38	0.8	1	86	72	78	61	90	69	57	53	110	90	80	37	20
18	105*47	129*60	0.7	0.7	109	108	97	98	115	112	58	55	114	83	83	25	28
19	95*40	97*43	0.7	1	97	70	97	64	115	88	46	53	99	88	86	41	11
20	96*38	105*50	0.9	0.9	96	97	67	67	77	76	53	50	103	80	78	27	21
21	107*53	123*60	0.6	1	109	66	115	63	120	72	48	49	97	84	84	35	10
22	101*35	115*40	0.8	1	85	66	74	57	82	61	55	46	101	76	73	21	22
23	113*36	101*37	0.8	1.2	76	49	82	50	96	57	54	52	106	76	82	34	27
24	98*43	110*50	0.8	1	104	80	80	61	94	69	63	51	114	90	82	31	28
25	97*36	113*40	0.9	1.1	82	70	66	52	74	58	57	57	114	73	78	16	31
26	98*45	103*50	1	1.2	103	76	87	66	100	73	50	52	102	92	80	40	0
27	104*38	110*45	0.8	1	101	76	100	76	99	82	52	52	104	78	73	26	21
28	96*41	103*42	0.77	0.9	101	83	82	67	95	76	51	49	100	72	78	29	26
29	90*40	95*45	0.9	1	57	50	66	58	73	63	45	45	90	74	75	30	13
30	91*46	98*49	0.9	1	78	69	67	59	76	66	45	49	94	78	78	33	14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Introduction
Chronic kidney disease (CKD) is defined[1] by KDIGO as abnormalities of kidney function or structure, present for more than 3 months, with implications for health:
1. Albuminuria >30mg/ 24 hours
2. Abnormal urinary sediments
3. Dyselectrolytemias and other abnormalities due to tubular disorders
4. Abnormal histology
5. Abnormal imaging
6. History of renal transplantation.
7. Decreased GFR < 60 ml/ min/1.73m^2 (GFR categories G3a – 5)
Based on Glomerular filtration rate (GFR), the 5 categories are
Category GFR in ml/ min per 1.73 m^2
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